

LARVAL DEVELOPMENT OF THE ZEIFORM FISHES
ANTIGONIA CAPROS LOWE, 1843 AND *ZENOPSIS CONCHIFER*
(LOWE, 1852) FROM THE SOUTH WEST ATLANTIC

by

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ABSTRACT.— Based on size series of 12 larval *Antigonia capros* of 2.7 to 5.1 mm SL and 8 *Zenopsis conchifer* of 4.2 to 6.6 mm SL from the southwest Atlantic, ontogenetic development of both species is described. Head spination of *A. capros* revealed the same vertically directed spine formerly taken as diagnostic character for the related species *A. rubescens*. Myomere counts of 20 to 22 in the present material seem to be distinctive for *A. capros* compared to 25 myomeres of *A. rubescens*. The occurrence of *A. capros* larvae in the investigation area was restricted to austral autumn (April-June). The larvae were found in the tropical water of 23.9 to 26.0° C and 36.3 to 36.7 ‰ salinity over the outer continental shelf, north of 30° S. *Z. conchifer* larvae show a conspicuous uniformly brown colour all over, except for the tip of the notochord, which is transparent. Larval form is depressed, body depth of a 6.6 mm specimen is 46 % of SL. The 5 rays of the pelvic fins are pigmented and reach beyond the anus. 33 to 34 myomeres are counted in the postlarvae. From 4.2 mm onward, occipital and postocular spines appear on the head of *Z. conchifer*, which distinguishes this species from the closely related *Zeus faber*. The larvae of *Z. conchifer* occurred from July through November in tropical and mixed water of temperatures between 17.5 and 23.4° C and salinities of 32.2 to 36.3 ‰. Larvae were found over the slope of the continental shelf and over deep oceanic waters as far south as 34° S. Reproduction of both *A. capros* and *Z. conchifer* in the southwest Atlantic is related to the tropical water of the southward flowing Brasil current. *Z. conchifer* has the wider range of occurrence into subtropical latitudes both as adult and as larvae, whereas *A. capros* is a typically tropical species reproducing north of latitude 30° S only.

RÉSUMÉ.— A partir d'une série de 12 larves d'*Antigonia capros* de 2,7 à 5,1 mm LS et de 8 *Zenopsis conchifer* de 4,2 à 6,6 mm LS, provenant de l'Atlantique sud-ouest, le développement ontogénique des deux espèces est décrit. La garniture épineuse céphalique de *A. capros* montre la présence de la même épine dirigée verticalement qui servait auparavant de caractère distinctif de l'espèce voisine *A. rubescens*. Dans les séries étudiées, le nombre de myomères varie de 20 à 22 chez *A. capros*, alors qu'il est de 25 chez *A. rubescens*. La présence de larves d'*A. capros*, dans la région étudiée s'est limitée à l'automne austral (avril-juin). Les larves ont été trouvées dans les eaux tropicales (23,9 à 26,0° C et 36,3 à 36,7 ‰ de salinité), au-dessus du bord de la marge continentale, au nord de 30° S. Les larves de *Z. conchifer* ont une teinte brune uniforme très remarquable, sauf au niveau de l'extrémité de la notochorde qui est transparente. Les formes larvaires sont déprimées, la hauteur du corps d'un exemplaire de 6,6 mm étant égale à 46 % de la longueur standard. Les 5 rayons de nageoires pelviennes sont pigmen-

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tés et dépassent l'anus. Les post-larves possèdent 33 à 34 myomères. A partir de 4,2 mm de longueur, des épines occipitales et post-oculaires apparaissent sur la tête de *Z. conchifer*, ce qui distingue cette espèce de l'espèce voisine *Zeus faber*. Les larves de *Z. conchifer* sont présentes de juillet à novembre dans les eaux tropicales et tempérées chaudes, à des températures comprises entre 17,5 et 23,4° C et des salinités comprises entre 32,2 et 36,3 ‰. Les larves ont été trouvées au-dessus de la pente continentale et au-dessus des grandes profondeurs jusqu'à 34° S. La reproduction des deux espèces *A. capros* et *Z. conchifer* dans l'Atlantique sud-ouest est liée aux eaux tropicales du courant du Brésil, dirigé vers le Sud. *Z. conchifer* possède la plus grande aire de distribution dans les latitudes subtropicales, à l'état adulte comme à l'état larvaire, tandis qu'*A. capros* est une espèce typiquement tropicale qui ne se reproduit qu'au nord de 30° S.

Keywords : *Antigonia capros*, *Zenopsis conchifer*, *Antigonia rubescens*, *Zeus faber*, Zeidae, Caproidae, ASW West Atlantic, Fish larvae, Larval development.

Of the fishes of the order Zeiformes, only the species *Antigonia capros* and *Zenopsis conchifer* (families Caproidae and Zeidae, respectively) occur regularly in the southwest Atlantic (Ringuelet, 1960; Roux, 1973; Stehmann, 1978; Figueiredo & Menezes, 1980). Both species are widely distributed in the deeper waters of the tropical oceans (Krefft, 1978; Wheeler, 1978). Larval and postlarval stages of *Antigonia* and *Zenopsis* are not common in ichthyoplankton collections. Thus, descriptions of the development of *Zenopsis conchifer* have not been published, so far. Juveniles of the species were described by Saldanha (1960). In the present collection, a size series of *Z. conchifer* allows for a first description of the early stages from the waters off the Brazilian coast.

The existing description of postlarval *Antigonia capros* was based on two individuals only (Nakahara, 1962). A further record of a postlarva from Japanese waters was given by Motoda (1966). This paper presents additional data on the development of head spination and body proportions from a small series of different sizes of *A. capros*.

MATERIAL AND METHODS

From 1977 to 1982, plankton was sampled on nine cruises in the southwest Atlantic between 23° S and 40° S. Four expeditions («Op. Rio de Janeiro I»; «CONVERSUT I - III») were made with the research vessel NOC «Almirante Saldanha» of the Brazilian Hydrographic Office (DHN), and 5 cruises («AREPE 1 - 5») were realized with the University of Rio Grande research vessel «Atlantico Sul». The samples were taken with 80 cm (or 60 cm) diameter conical plankton nets equipped with 250 µm nylon gauze (A. Saldanha cruises) or with bongo nets equipped with 300 µm gauze (Atlantico Sul cruises). The nets were hauled obliquely through the upper 200 m water layer. In addition, vertical hauls were made in the same depths. A total of 445 bongo net hauls, and 551 oblique and 390 vertical hauls with the conical net were made during all seasons of the year.

The plankton was fixed and stored in 4-5 % borax buffered formaldehyde. Juvenile and adult specimens of *A. capros* and *Z. conchifer* were obtained from bottom trawl sampling with RV «Atlantico Sul» off the coast of Rio Grande do Sul state.

Morphometric measurements and meristics counts were made after staining with aliza-

rine-red. Due to preservation in glycerine, a general account for shrinking has to be made for the measurements. Head length was taken horizontally from the snout to the posterior margin of the opercle. Preanal and prepelvic lengths are the projections on a horizontal line from snout to anus or base of pelvic fin, respectively. Body depth was taken at the position of the vertical head spine in *A. capros* and at the posterior margin of the opercle for *Z. conchifer*, respectively. Due to the difficulty to define a representative starting point of the spines of *A. capros* we measured the lengths of the occipital and preopercular spines as projections on the horizontal line between snout and tip of the spines. All length measurements were calculated as percentages of notochord length (NL) or standard length (SL) after notochord flexion.

OCCURRENCE OF THE LARVAE

In the entire ichthyoplankton collection, 12 larvae of *A. capros* and 8 of *Z. conchifer* were identified (Tables I and II).

Table I : Catch data for postlarval *A. capros* in the S W Atlantic

cruise	station	position	date	bottom depth (m)	T (C) (10m)	S % (10m)	n-larvae
OP R.d.Janeiro I	4448	23°56'S/43°57'W	10/06/77	133	23.9	36.5	1
OP R.d.Janeiro I	4489	23°49'S/43°13'W	13/06/77	135	24.0	36.7	1
AREPE I	15	30°11'S/48°19'W	05/04/80	207	26.0	—	1
CONVERSUT III	5828	27°51'S/47°19'W	05/04/81	229	24.8	36.7	8
CONVERSUT III	5846	26°36'S/46°46'W	10/04/81	176	24.9	36.3	1

Table II : Catch data for postlarval *Z. conchifer* in the S W Atlantic

cruise	station	position	date	bottom depth (m)	T (C) (10m)	S % (10m)	n-larvae
CONVERSUT I	4584	34°09'S/50°06'W	24/09/77	2500	20.2	36.0	1
CONVERSUT I	4594	33°22'S/50°24'W	01/10/77	715	20.1	35.3	1
CONVERSUT I	4672	29°35'S/46°00'W	01/11/77	3000	23.1	36.4	1
CONVERSUT I	4673	29°54'S/45°37'W	01/11/77	3000	23.4	36.3	1
CONVERSUT I	4709	26°26'S/45°59'W	14/11/77	600	21.8	35.7	1
AREPE II	109	29°01'S/48°12'W	29/07/80	129	18.8	32.2	1
AREPE II	184	33°55'S/51°21'W	15/08/80	213	17.5	35.0	1
AREPE III	239	33°41'S/51°00'W	29/10/80	228	19.2	33.2	1

A. capros catches were made in the months of April and June (austral autumn). The larvae occurred over the outer continental shelf over water depths of 133 - 230 m. Southern limit of occurrence was 30°11' S (Fig. 1).

Larval *Z. conchifer* appeared in the catches between July and November, i.e. in winter/spring. One group of larvae occurred in the northern part of the investigated area between 26° S and 30° S and another record of the species was made

at 34° S. *Z. conchifer* occurred over the slope of the continental shelf and further offshore over deep oceanic waters (Fig. 1).

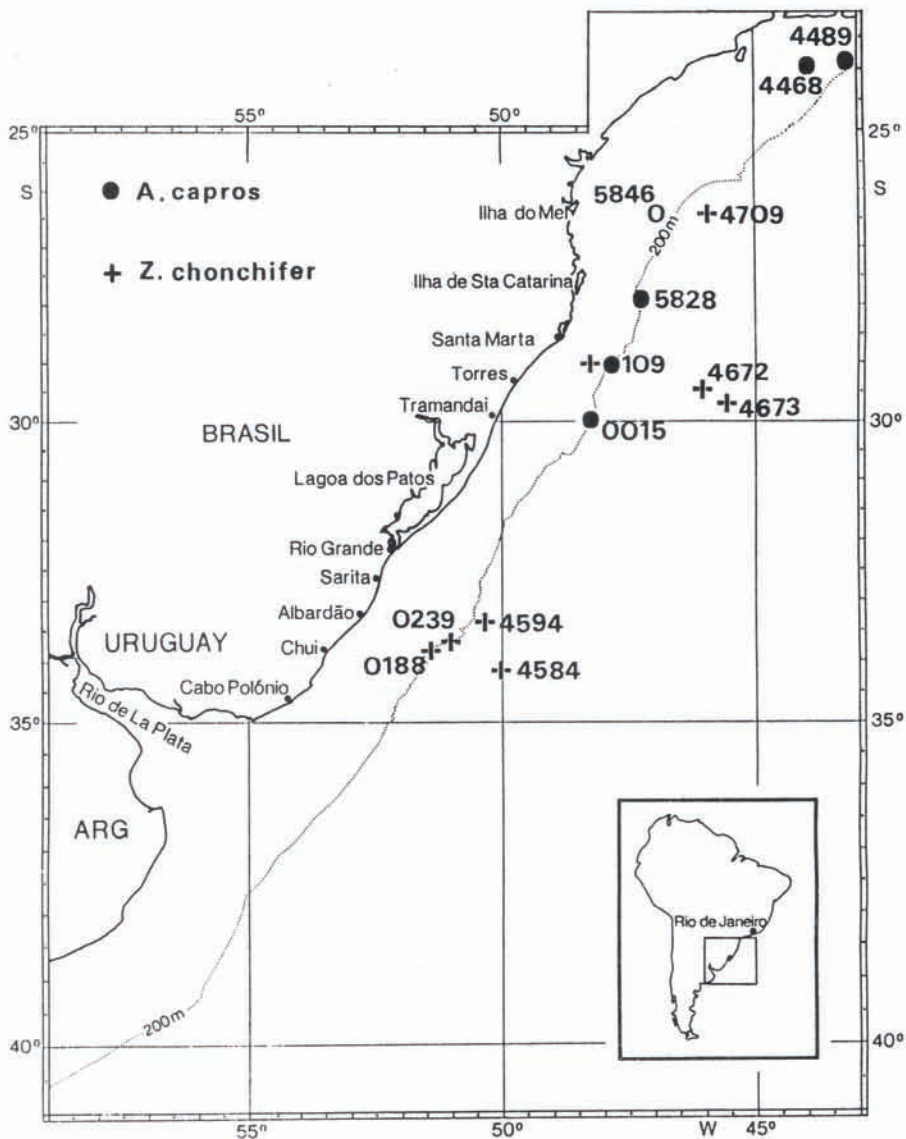


Fig. 1.— Occurrence of postlarval *Antigonía capros* and *Zenopsis conchifer* in the southwest Atlantic. Position of stations and dates of collection given in Tables 1 and 2.

Surface temperatures (10 m values) ranged from 23.9 to 26.0° C and surface salinities (10 m values) from 36.3 to 36.7 ‰ for positive *A. capros* stations. The respective values for *Z. conchifer* are 17.5 - 23.4° C and 32.2 - 36.4 ‰ (Tables I and II).

DESCRIPTION OF THE LARVAE

Antigonia capros (Fig. 2)

The smallest larva of 2.7 mm SL (Fig. 2a) is of robust shape with a relative body depth of 33 % SL. Head length equals 33 % and preanal distance 63 % of SL (Table III).

A serrated crista extends from the top of the head to the occipital region with one stronger spine at each end. Serrated ridges are present on the upper and lower jaws. A strong, slightly serrated spine, accompanied by three smaller spines extends from the angle of the preopercle backwards.

Pigmentation is weak in this specimen, probably due to storage. A set of melanophores is located in the peritoneal region; one melanophore is found occipital on the head and one on the upper jaw. The gut is well developed and no yolk remains

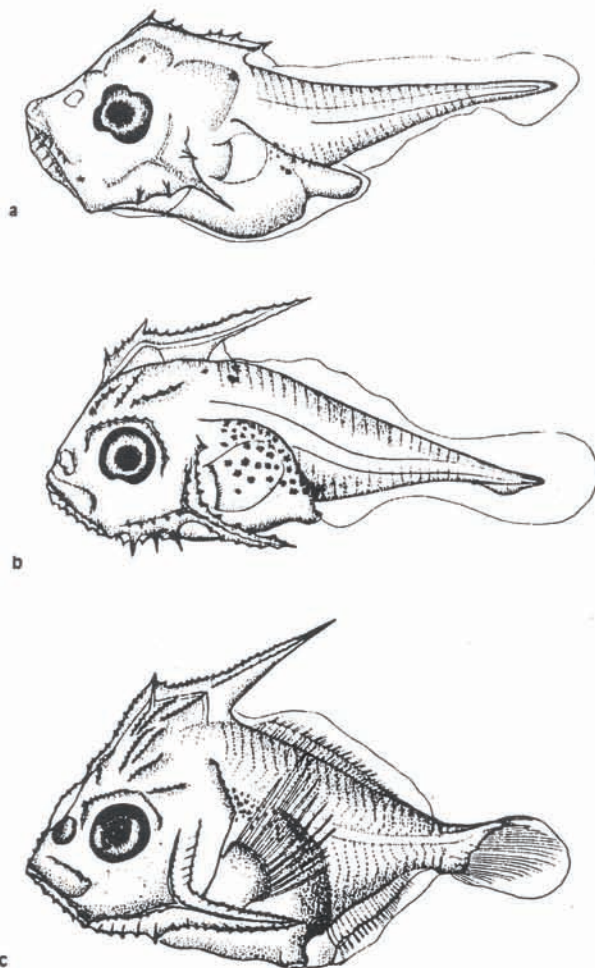


Fig. 2.— Development of *Antigonia capros*. a) 2.7 mm SL; b) 3.0 mm SL; c) 4.5 mm SL.

Table III : Body proportions of postlarval *Antigonita capros*. (SL : Standard Length ;
HL : Head Length; : PAD : Preanal Distance; BD : Body Depth; Myo : No. of myomeres;
OCSP : Occipital Spine Length; POPS : Preopercular Spine Length.

No.	SL(mm)	HL(mm)	HL(%SL)	PAD(mm)	PAD(%SL)	BD(mm)	BD(%SL)	Myo	OCSP(mm)	OCSP(%SL)	POPS(mm)	POPS(%SL)
1	2.7	0.9	33	1.7	63	0.9	33	22	1.2	45	1.0	37
2	3.0	1.1	37	1.8	60	1.1	37	22	1.6	53	1.6	53
3	3.6	1.5	42	2.5	69	1.8	50	21	2.5	70	2.4	67
4	3.8	1.6	42	2.6	68	2.0	53	21	2.2	58	2.7	71
5	4.0	1.5	38	2.4	60	1.9	48	22	2.6	65	2.7	68
6	4.0	1.5	40	2.4	60	2.1	53	—	2.5	63	2.5	63
7	4.2	1.6	38	2.4	57	2.4	57	22	2.6	62	3.0	71
8	4.3	1.8	42	2.7	63	2.5	58	22	2.7	63	2.9	67
9	4.3	1.8	42	2.8	65	2.2	51	22	2.8	65	2.8	65
10	4.4	1.7	39	2.7	61	2.5	57	22	2.5	57	3.0	68
11	4.6	2.0	44	2.9	63	2.7	58	22	2.6	57	2.9	63
12	5.1	2.2	43	3.3	65	3.2	63	20	3.3	65	3.3	65

Juveniles and adults

SL (mm)	HL (%SL)	PAD (%SL)	BD (%SL)
27.0 - 47.0 (n = 15)	41 (range : 38 - 52) %	55 (range : 44 - 66) %	119 (range : 110 - 129) %
62.0 - 158.0 (n = 18)	35 (range : 31 - 38) %	54 (range : 48 - 62) %	109 (range : 89 - 120) %

are found. The functional mouth is in superior position. The pectoral fins are developed as membranous structures and a primordial finfold is present. 22 myomeres are counted.

At 3 mm SL (Fig. 2b) body depth has increased to 38 % of SL. Relative head length (30 %) and preanal length (59 %) remain roughly unchanged. The crista terminates in an oblique spine in the occipital part and a smaller vertical spine in the frontal part, accompanied by three smaller spines on the forehead. The preopercular spine has increased in length to 53 % of SL and the margin of the preopercle is serrated especially in the ventral part. On the preopercle, a serrated ridge follows the edge and extends onto the main spine. Further serrated ridges appear in a supra-orbital and a frontal position on the head. 22 myomeres are counted in this specimen. The primordial finfold persists. Developing rays are found in the pectoral fin. A series of melanophores is located on the peritoneum and single pigment cells are found dorsally.

In the 4.5 mm postlarva, (Fig. 2c), body depth has increased to 60 % of SL and preanal and head lengths to 68 % and 44 %, respectively. The larva is armed with a strong occipital spine and preopercular spines which reach the anus. The serrated crista on top of the head shows a well developed vertical spine in supraorbital position and a series of smaller spines on a frontal ridge. Further serrated ridges are found supraorbital, and on the preopercle.

In the specimen shown in Fig. 2c, notochord flexion is under way, and dorsal-, anal- and caudal finrays are incipient.

Approximately 30 dorsal finrays can be counted. 12 pectoral finrays are developed, and 22 myomeres can be distinguished. The larva is sparsely pigmented probably due to storage. A series of melanophores is found on the peritoneum.

At 5.1 mm SL, dorsal and anal spines are present. Countable rays are D : VI/34, A : II/30. The body depth increased further to 63 % SL.

In addition to the postlarvae, body proportions of 15 juvenile and 18 adult *A. capros* were analyzed (Table III). Mean relative head length was 41 % in juveniles up to 50 mm SL. Head length of adults decreased to 35 % SL. The preanal distance of over 60 % in the postlarvae decreased to about 55 and 54 % in juveniles and adults, respectively. Relative body depth is greatest at juvenile sizes (119 % SL) and decreases at older ages (Mean : 109 %). Number of vertebrae in juvenile specimens was 21 - 22 ; finray counts were within the limits presented by Berry (1959) and Figueiredo and Menezes (1980) : D : VII-IX/31-37 ; A : III/29-34. The pectorals have one small spine and 13 soft rays.

***Zenopsis conchifer* (Fig. 3)**

The smallest larva of 4.2 mm SL (Fig. 3a) shows remains of the yolk-sac. At the same time, the mouth is already well developed and functional. The primordial finfold surrounds the larva from head to anus. The larva is relatively slender, body depth is 21 % of SL (Table IV). Head length equals 21 % SL and the preanal distance is 52 % of SL. 34 myomeres are counted. A spine is present on the head in occipital position. The pelvic fins appear ventrolateral as membranous structures

Table IV : Body proportions of postlarval *Zenopsis conchifer*. (SL : Standard Length ;
HL : Head Length; PAD : Preanal Distance; BD : Body Depth at end of head; PPD : Pre-Pelvic Distance)

No.	SL (mm)	HL (mm)	% SL	PAD (mm)	% SL	BD (mm)	% SL	PPD (mm)	% SL	Myomeres
1	4.2	0.9	21	2.2	52	0.9	21	1.4	33	34
2	4.3	1.2	28	2.3	54	1.1	26	1.5	35	—
3	4.3	1.2	28	2.3	54	1.1	26	1.5	35	34
4	4.6	1.2	26	2.3	50	1.3	28	1.6	35	33
5	4.6	1.4	30	2.3	50	1.7	37	1.6	35	34
6	4.8	1.3	27	2.7	56	1.8	38	1.6	33	34
7	5.2	1.5	29	2.8	54	1.7	33	1.6	31	34
8	6.6	2.6	39	4.5	68	3.0	46	3.4	51	34
Juveniles										
1	54.0	20.0	37	28.0	52	34.0	63	—	—	Vertebr. 35
2	66.0	26.0	39	35.0	53	43.0	65	—	—	35
3	71.0	28.0	39	39.0	55	41.0	58	—	—	—
4	71.0	29.0	40	41.0	57	44.0	62	—	—	—

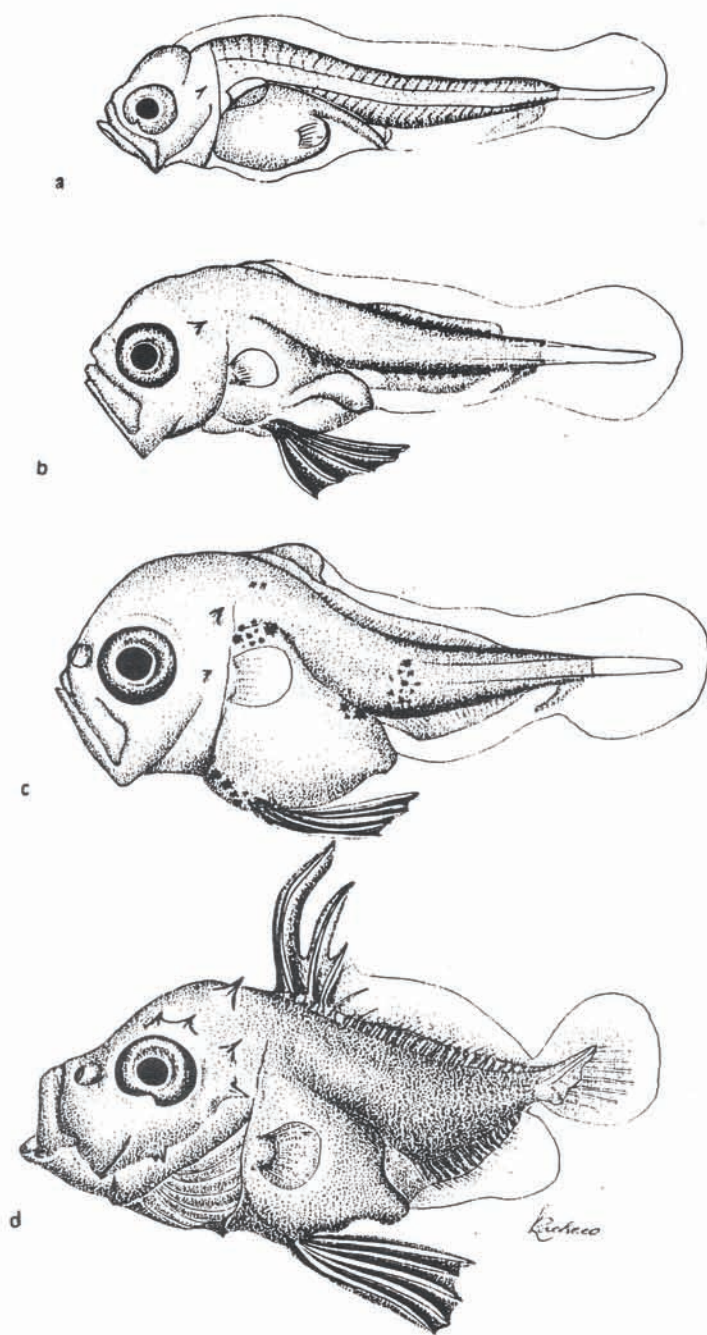


Fig. 3.— Development of *Zenopsis conchifer*. a) 4.2 mm SL; b) 4.6 mm SL; c) 4.8 mm SL; d) 6.6 mm SL.

at a position of 33 % of SL. Head and trunk of the larva are brown in colour except for the transparent tip of the urostyle. The eyes are light-brown in colour and the coroid fissure is still visible. A diffuse brown pigmentation was present ventro-caudally in the formalin preserved larva, but disappeared after storage in glycerine.

The postlarva of 4.6 mm SL (Fig. 3b) shows considerably altered body proportions. The yolk is completely absorbed. Head length has increased to 26 % SL and body depth to 28 % SL. Preanal and pre-pelvic distances remain roughly unchanged at 50 and 35 %, respectively. The pelvics are positioned ventrally now, due to the complete absorption of yolk. Five well developed and dark pigmented rays form the pelvics, which reach beyond the anus. The primordial finfold persists, and the finrays of the first and second dorsal, as well as of the anal fin are visible. The head continues with one occipital spine. The general pigment pattern remains unchanged showing the conspicuous brown colour of head and trunk and the transparent caudal tip. The eyes are now dark brown without visible choroid fissure. 34 myomeres can be counted in the specimen.

At 4.8 mm SL (Fig. 3c), the main change in postlarval proportions refers to increasing body depth, reaching 38 % of SL at this size. Head length and preanal distance have increased slightly; the position of the pelvics is almost unchanged at 33 % SL. A second spine appears on the head in postorbital position. The primordial finfold persists and the finrays of dorsal and anal fins are well advanced. The pectoral shows incipient rays. The dark brown ventrals are well developed and reach beyond the anus. A series of melanophores appears ventrally on the peritoneum, and laterally on the trunk. The specimen has 34 myomeres.

The largest identified specimen of 6.6 mm SL shows onset of notochord flexion (Fig. 3d). The head is very large (39 % of SL) and armed with occipital, supraorbital, and postorbital spines. A smaller spine appears on the preopercle in suborbital position. Preanal length is 68 %, and body depth 46 % of SL. 34 myomeres are counted. The pelvics are dislocated backwards to a position at 51 % of SL and reach beyond the anus. Four spines are developed in the dorsal, and 25 finrays can be counted in each fin. The coloration of the larva is brown and the caudal region is significantly lighter in colour.

DISCUSSION

Uchida (1936) presented a 3.0 and a 6.5 mm (total length) zeiform postlarva, which he identified 'provisionally' as *Antignonia rubescens*, based on the evidence of the common occurrence of adults of this species in the area. The largest of his specimens shows a serrated dorsal median keel with long oblique spine and a short vertical spine in the supraorbital region, as well as a series of serrated ridges on the head. The larva has 25 myomeres and is at a stage before notochord flexion.

In 1962, Nakahara described two postlarvae of *A. capros* which differed in several aspects from Uchida's *A. rubescens*. Tighe and Keene (1984) reviewed the ontogeny of zeiform fishes and referred to these publications. In their view, the most obvious difference between the postlarvae of both species is the presence of the vertically directed spine on the head of *A. rubescens*. However, in a catalogue

published by Motoda (1966), a 4.6 mm postlarva of *A. capros* is shown with a well developed vertical head spine. The diagnostic value of this structure may be questioned, considering the small number of investigated specimens. In the present material of southwest Atlantic *Antigonia capros* characters of both Uchida's and Nakahara's larval types are represented. In the developmental series shown in Fig. 2, the vertical spine is evident at all sizes. Further characters resembling the *A. rubescens* larva are the body depth of 58 % SL and the lack of melanophores on the head. On the other hand, our *A. capros* agrees with those of Nakahara in the number of myomeres (20-22), elevated number of dorsal finrays (ca. 30), the advanced stage of notochord flexion at the given size, and the lack (except for one specimen) of melanophores on the hypurals.

Leaving aside the variable (due to preservation) pigment pattern, and the not fully countable dorsal finrays, the most obvious distinctive characters seem to be the size at notochord flexion and the difference in the myomere counts (20-22 vs 25) although the *A. rubescens* values are based on only one postlarva (Uchida, 1936). Considering the constant presence of the vertical spine in our material and in Motoda's (1966) drawing, the lack of this structure in Nakahara's larvae may be the result of some damage during catch or handling.

Body proportions, e.g. relative body depth do not seem to be distinctive characters of the species. Within *A. capros*, the changes of body proportions throughout the sizes are consistent, but show considerable individual variation. The proportions from the present series well agree with the values given for *A. capros* by Berry (1959). A postlarva of 6.2 mm mentioned by him fits with a relative body depth of 84 % SL in between our largest postlarva (BD = 58 % SL) and the mean value for the juveniles (BD = 119 % SL).

The occurrence of the post larval *A. capros* in the southwest Atlantic is apparently confined to a very short period in austral autumn (april - june) and to the area north of 30° S. Over the slope of the continental shelf, a general southward transport can be assumed in the south flowing waters of the Brasil Current (Hubold, 1980a, b). Spawning grounds of *A. capros* may therefore be located north of the catch position, e.g. off the coasts of Paraná to Rio de Janeiro. Main distribution of adult *A. capros* is to the north of Rio de Janeiro (Berry, 1959), although catches are reported as far south as the coast of Uruguay (Figueiredo and Menezes, 1980). The limited presence of postlarval *A. capros* may therefore be due to the limit of the southern extension of the species in the investigated area at about 30° S.

Records of adult *Zenopsis conchifer* are known from at least as far south as 40° S (Gosztonyi, 1981) off the Argentinean coast. Larvae, however, were not described from the extensive ichthyoplankton collections in that area (e.g. Ciechomski, 1981). The present occurrence at 34° S may therefore be the southernmost spawning site in the southwest Atlantic. Adult stocks have not yet been demonstrated for the area.

At 29°, the occurrence of postlarval *Z. conchifer* can be related to a concentration of adults known from the continental slope off Cabo Santa Marta. These fishes were observed in the austral spring and summer (Yesaki *et al.*, 1976), whereas the post larvae appeared in late winter (July) to spring (November).

Ontogenetic development of *Z. conchifer* very much resembles the related species *Zeus faber* (Sanzo, 1913 ; Crossland, 1982). Yolk-sac larvae are comparably large (4,2 mm) and the conspicuous brown coloured body with the transparent caudal tip is common in both species. The presence of spines on the head of *Z. conchifer* seems to be the most distinctive difference at postlarval level between the species, as spination does not seem to occur in *Zeus faber*.

The body proportions of *Z. conchifer* do not change drastically from postlarval to juvenile sizes (Table IV). Relative head length (39 %) of the 6.6 mm postlarva is comparable to the 37-40 % head length of juveniles. The preanal distance of the 6.6 mm specimen seems to be unusually great, compared to the smaller larvae and the juveniles. The main change from postlarva to juvenile refers to body depth which increases from 21 % of SL in the yolk-sac larva to 65 % in the juvenile specimen of 60 mm SL. Vertebral counts in the juveniles (35) agree with the 34 myomeres found in the post-larvae.

The reproduction of the zeiform fishes *Antigonia capros* and *Zenopsis conchifer* in the southwest Atlantic is related to the warm, high salinity water of the southward flowing Brasil Current. Although the adult *Zenopsis* occur also on the argentinean shelf in coastal waters, the southern most occurrence of the postlarvae can be hydrographically defined as being in a terminal zone of the Brasil Current, mixed with south brazilian Coastal Water (Hubold, 1980a, b).

Adult *A. capros* range to the south only to the coast of Uruguay, i.e. they do not leave the regime of the Tropical Water. Their main distribution is in more northerly areas. The southern most occurrence at 30° S of the *A. capros* postlarvae confirm the tropical character of this species.

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